2003 STATE-COUNTY GROUND WATER SYMPOSIUM

September 25, 2003

Morning Plenary Session (Boston Theater)

9:00 – 9:10 **Opening Remarks**
Norman Lazarus, MDE, Water Management Administration

9:10 – 9:30 **Keynote Address**
Kendl Philbrick, Acting Secretary, MDE

9:30 – 10:05 **Strategies for reducing Nitrate Contamination of Shallow Ground Water**
Ken Staver, Univ. of MD Wye Research and Education Center

B R E A K

Time	Boston Theater	Chesapeake III Room	Harbor Ballroom
10:20 – 10:50	**Maryland's Voluntary Cleanup Program: New Experiences, New Challenges** *Karl Kalbacher* MDE, Waste Mgt. Adm.	**Source Water Assessments for Small Public Water Systems in Baltimore County** *Harvey Cohen* S.S.Papadopulos & Assoc., Inc.	**Operations & Maintenance, Lots of Talk; Where's the Beef?** *Craig Goodwin* NCS Wastewater Solutions
10:55 – 11:25	**UST Releases to Shallow Domestic Wells in Maryland** *Forest Arnold & Ken Carter* MDE, Waste Mgt. Adm.	**Well Construction Problems in Carroll County** *Brian Flynn* Carroll Co. Health Dept.	**Large System Onsite Sewage Disposal** *Jay Prager & Dr. C.T.Tien* MDE, Water Mgmt. Adm.
11:30 – 12:00	**Use of Innovative Ground Water Investigation Technologies at a Maryland Federal Superfund Site** *Steve Maloney* ENTECH, Inc.	**UV Disinfection of a 350 GPM Ground Water Supply** *John Civardi* Hatch Mott MacDonald	**Assessing Nutrient Sources using Macroalgal Stable Isotopes as Bioindicators in Chesapeake Bay** *William Dennison* Univ. of MD Center for Environmental Science

L U N C H (Chesapeake I and II)

Afternoon Plenary Session (Boston Theater)

1:00 – 1:40 Using a Geographic Information System as an Essential Tool in a Local Environmental Health Setting

Brian Chew and Bridget Byers, Anne Arundel County Dept. of Health

Time	Boston Theater	Chesapeake III Room	Harbor Ballroom
1:45 – 2:15	**A Geochemical Discussion of Iron Sand Remedial Treatment of Arsenic and Chlorinated Hydrocarbon Compounds in Ground Water** *Jim Lolcama* KCF Groundwater Inc.	**Use of Fluorometric Methods to Determine Sources of Bacterial Contamination in Drinking Water Systems near Boonesboro, MD** *Bill Evans* MDE, TARSA	**Ground Water Quality Atlas Forum:** **Information exchange for the development of a Statewide Ground Water Quality Atlas**
2:20 – 2:50	**St. Mary's County Ground Water – Status, Problems, Solutions** *John B. Wheeler* St. Mary's County Water Policy Task Force	**Dry Cleaner's Guide to Wastewater Management** *Susan Allen* MDE, Water Mgmt. Adm.	*Dave Bolton* Maryland Geological Survey

B R E A K

Time	Boston Theater	Chesapeake III Room	Harbor Ballroom
3:05 – 3:35	**Predicting the Likelihood of Elevated Concentrations of Nitrates in Ground Water for the Mid-Atlantic Region** *Earl Greene* U.S. Geological Survey	**Alaskan Earthquake Mysteriously Thieves Water from Pennsylvania Municipal Water Supply Well** *Mark Eisner* and *James Wilburn, IV* Advanced Land and Water, Inc.	**An Optimized Observation – Well Network for Monitoring Ground Water Levels in Maryland** *Doug Yeskis* US Geological Survey
3:40 – 4:10	**Radium in Ground Water and Formation Geochemistry at Two Coreholes, Anne Arundel County** *Mark Duigon* Maryland Geological Survey	**Application of Geophysical Methods for Ground Water Characterization** *Beth A. Williams* ARM Group, Inc.	**From Drought to Flood** *Wendy McPherson* U.S. Geological Survey

Abstracts are available for those in *blue font*. For more information, please contact Norman Lazarus at 410-537-4167 or via email at nlazarus@mde.state.md.us

Source Water Assessment of Small Public Water Systems in Baltimore County, MD – Maximizing GIS-Database Linkages for Effective Management

Harvey A. Cohen and S.J. Cousins, S. S. Papadopulos & Associates, Bethesda, MD

Abstract

On behalf of the Maryland Department of the Environment (MDE), Source Water Assessments are currently being completed for 247 Small Public Water Systems in Baltimore County. These systems, composed of more than 300 individual wells, include 46 non-transient, non-community systems, and 201 transient, non-community systems. More than 200 individual Potential Contaminant Sources (PCS) were located in the field, about half of which had not been previously identified. Because of the large number of systems requiring evaluation, the project management aimed to maximize automation of GIS and database functionality, leaving staff to focus on site visits, quality control, and interpretation. Geographic and water quality data were managed through direct linkage of ESRI's ArcGIS to Microsoft Access. This allowed the scheduling of site visits, input/revision of point data, data interpretation, and generation of final maps to be automated to a great degree.

Water quality sampling records maintained by MDE and the Baltimore County Health Department were reviewed and updated for all systems. For transient systems, monitoring parameters were largely restricted to nitrate and coliform bacteria, whereas VOCs, SOCs, IOCs, and radiological parameters were also evaluated for non-transient systems. Overall, 20-30% of the transient and non-transient systems had tested positive for total coliform bacteria in at least one test since 1996, although systems with positive fecal coliform detections were rare. Nitrate exceedances were observed in nearly 10% of the transient systems and in fewer than 5% of the non-transient systems. Nitrate and coliform exceedances are associated with residential, agricultural, and forested land use areas suggesting that the primary sources of contaminants may include septic systems as well as non-point agricultural sources. Of the non-transient systems, over 35% had also reported at least one Radon-222 exceedance (of the proposed EPA MCL), consistent with the large number of wells screened in crystalline bedrock. For the sixty systems reporting VOC analyses, detections of BTEX, chlorination byproducts, chlorinated solvents, and common laboratory contaminants (phthalates, methylene chloride) were reported, there were virtually no MCL exceedances.

Under Maryland's Source Water Assessment Plan, the majority of these systems are assigned Source Water Assessment Areas (SWAAs) defined by a 1000 foot radius from the active wells; unconfined coastal-plain systems are assigned wedge-shaped SWAAs based upon groundwater flow direction. Custom VBA scripts were used to loop through the systems, generate composite buffers of the appropriate geometry, select the appropriate orthoquad images, and generate the final SWAA map. Geographic queries determined that over 40% of the system SWAAs impinged on underground storage tanks (active and abandoned in place) primarily used for fuel oil and gasoline. Fewer SWAAs (12%) impinged on known hazardous substance generators. Only about 5% of sites impinged on CERCLIS and VCP sites, or discharge-to-groundwater locations. Susceptibility analysis, based upon criteria set at ½ MCLs or Action Levels, indicates that risks due to source water factors include radon in crystalline basement and nitrate in all hydrogeologic settings. Other factors of concern include improper treatment of the pumped water supplies.

OPERATIONS & MAINTENANCE
LOTS OF TALK, WHERE'S THE BEEF?

Craig Goodwin, General Manager
NCS Wastewater Solutions

The onsite industry seems to be on a roll. Over 40% of new single family residences built each year have onsite wastewater treatment/reuse systems. The U.S. Environmental Protection Agency is on the public record recognizing that decentralized/onsite systems are viable and sometimes the preferred long-term solution. Technological growth and innovation within the industry is very healthy. Though still lacking the professional trade status afforded to plumbers and electricians, certification requirements for onsite installers are raising the bar, leading to higher quality installations and an economically more healthy industry. Onsite training centers spread across the country are institutionalizing continuing education. Health departments increasingly provide the opportunity to design and install performance based solutions with limited prescriptive requirements.

And after years of neglect, operations and maintenance (O&M) is a topic now seeing the light of day. You can't go to an onsite conference anymore that doesn't address O&M. So, with all this talk, where's the beef? What is really happening with O&M and is it working? Can it work?

Signs of Progress

Let's start with some clear signs of progress. Recognizing the importance of providing a management infrastructure for the long-term success of decentralized/onsite systems, the U.S. Environmental Protection Agency last year published a set of draft management guidelines[1]. Particularly helpful is the risk-based model provided for determining what type of institutional framework may be needed. However, because it also addresses the potential of creating utilities in higher risk environments, not all within our industry have applauded, worried about losing private sector business to public entities. This debate (and implied threat) is good for the industry.

The WOSSA Training Center here in Washington last year conducted training for over 1,000 course enrollees. More than 25% of these course hours are now being devoted to O&M, up from zero not too long ago.[2] County health departments in Washington State (and elsewhere in the country), are implementing formal monitoring programs to insure that homeowners with "alternative systems" have management contracts in place or have regular inspection provided. And perhaps one of the best indicators of progress is that many manufacturers are now bringing a wide variety of

[1] U.S. Environmental Protection Agency, **Draft EPA Guidelines For Management Of Onsite/Decentralized Wastewater Systems**, September 26, 2000.
[2] Estimate provided by David Lenning, Director, WOSSA Training Center.

monitoring equipment and management services to the market. Where there is a viable market, manufacturers and service providers will step in.

Challenges Ahead

Perhaps the biggest challenge is that we are starting with very limited infrastructure now in place. Of the roughly 26,000,000 U.S. households with onsite systems, it is estimated that only 500,000 of these in 15 states have regular management provided.[3]   Reported malfunction or failure rates with onsite systems are very high, ranging from 6% reported by homeowners[4] to 25% when inspected by trained personnel.[5]

It is also reported that septic systems constitute the third most common source of ground water contamination[6].   Malfunctioning onsite systems are considered to be a major contributing factor in 32% of all harvest-limited shellfish growing areas[7], 36% of impaired miles of ocean shoreline[8] and 168,000 viral and 34,000 bacterial illnesses each year.[9] Who's going to pay the bill to fix these problems and manage them in the future?

If the problem rate is high for existing onsite systems, which are largely simple septic tank and gravity drainfields, what will be the impact of installing more complex "alternative" or "performance based" systems at higher risk sites?

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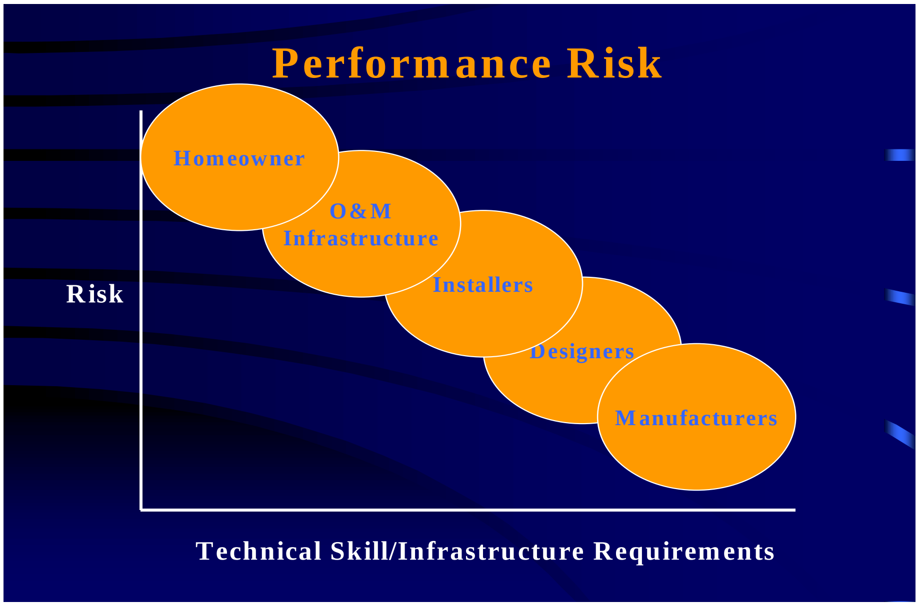
[3] U.S. Environmental Protection Agency, National Small Flows Clearinghouse, 2001.
[4] American Housing Bureau, Homeowners Survey, 1999.
[5] Nelson, V.I., S.P.Dix and F. Shepard, **Advanced On-Site Wastewater Treatment Management Scoping Study: Assessment of Short-Term Opportunities and Long-Run Potential (DRAFT),** May 1999. Data based on reporting from onsite system inspections in Massachusetts.
[6] U.S. Environmental Protection Agency, **National Water Quality Inventory Report to Congress (305(b) Report),** 1995.
[7] U.S. Environmental Protection Agency, **1996 Clean Water Needs Survey Report to Congress**, September, 1997. (EPA 832/R-97-003).
[8] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, **National Shellfish Register**, 1995.
[9] U.S. Environmental Protection Agency, **40 CFR Parts 141 and 142: National Primary Drinking Water Regulations: Ground Water Rule; Proposed Rules**, Federal Register, May 10, 2000.



The preceding chart illustrates the increasing challenges faced as a result of additional technical complexity and site risk. What may seem simple and low risk to a manufacturer is not so simple to a designer, installer, O&M service provider and certainly not to a homeowner. Because we have the technology, we are able to reduce drainfield sizing and use onsite systems on very challenging sites otherwise unbuildable. With the homeowner paying the bill and ultimately making the decisions, will this structure work? How do we mitigate this built-in risk?

Some Tough Questions For The Future

1. Can we count on homeowners to voluntarily contract and pay for O&M service?

You be the judge. History is not on our side.

2. If voluntary O&M won't work, are we prepared to mandate management service requirements?

Mandatory O&M requirements across the country are still the exception and not the rule. It takes significant political will to overcome objections to more government regulation, interference in homeowner lives etc. that invariably get raised. Unless the "problem" to be solved is perceived to be great enough, mandatory requirements are a tough sell.

For example, in Texas where spray irrigation is widely used at individual homes and the potential risks to public health are quite high if treatment systems are not operated properly, the political will is currently not there at the State level to mandate service requirements to homeowners. The Texas legislature would not pass legislation mandating statewide O&M service requirements this past session. The resulting burden falls on the shoulders of each individual county Health Department – as it does in most parts of the country.

3. Are we prepared to invest in the required local Health Department infrastructure to monitor mandatory O&M requirements?

For those counties willing to step up to the plate, there are significant resource implications. Kitsap County here in Washington currently has nearly 50,000 septic systems in the ground. Of these, approximately 2,500 are classified as "alternative systems" for which homeowners are required to have management service contracts in place. Aerobic treatment units and sand filters are the most common of these alternative systems. Alternative systems are used to downsize drainfields and/or reduce groundwater separation distances.

Recognizing the need and importance of tracking these systems and educating homeowners about the need, the Kitsap County Department of Health has assigned one full time person to the task. In addition, the County invested significant resources to put in place the computer database systems needed for efficient tracking.

How many counties across the country are prepared to invest in and have the resources needed to fund effective O&M tracking and monitoring?

4. Are Health Departments prepared to take the required enforcement action if homeowners do not comply with O&M requirements?

Once educated as to the need for O&M, we might expect many, if not most, homeowners to "do the right thing". Unfortunately, history also shows us that some people will not do the right thing. Financial constraints, negative attitudes about government regulation, a lack of appreciation for the health risks involved or perhaps just pure obstinacy are all contributing factors.

Experience in Kitsap County provides some documented results. For homeowners who do not have management contracts in place, County practice calls for warning letters followed ultimately by issuance of a "ticket" for noncompliance. Civil infraction citations may be given with a possible penalty of $475 per day if ordered by a judge. Following is a summary of Kitsap County experience[10]:

Activity	**1999**	**2000**
30-Day Letters	261	413
7-Day Letters	62	230
Tickets Written	3	8

[10] Dave Snyder, R.S., WOSSA Board Member, **O&M Contracts – Homeowners Doing the Right Thing**, April 6, 2001.

Even under the best of conditions with significant resources dedicated to homeowner education and tracking, it is naïve to expect any O&M requirement to succeed without a willingness to exercise enforcement action. How many counties are ready, able and willing to take enforcement action?

Based on current enforcement (lack of enforcement) problems, it will take a sea change in attitude for effective enforcement to become integral to health department mandate and practice. This is not intended as a criticism or indictment of county health departments. The local political environment typically doesn't support enforcement action on voters. It's therefore fair to say that we should be skeptical about enforcement in the future. The oft seen image during my travels across the country of raw sewage on the ground, even oozing across parking lots or in children play areas, with no enforcement action taken, no doubt colors my perspective.

The following quote from a 1999 article in The Chronicle newspaper in Lewis County Washington sums up the regulatory challenges we still face:

"**During the past several years, an unsteady Lewis County vortex has swirled about the home sewage treatment machines. The milieu has included a police standoff, tense citizen-videotaped inspections, a government-ordered septic demolition, county employee firings, and last month's criminal trial of a former county inspector."**[11]

The life of a county regulator taking enforcement action can be interesting indeed.

5. What if performance based systems don't meet performance standards? Are we prepared to require the homeowner to replace their system?

Despite standardized testing protocols and certification requirements, some performance based systems will not meet standards. Meeting nitrogen limits are particularly challenging as regulators in Massachusetts and Pennsylvania will readily attest. Because of wide differences in homeowner habits, climatic conditions and water supply alkalinity, a treatment system tested, say in Florida and claiming 10 mg/L Total N results, will not translate into equivalent performance in New England or the Midwest. For example, if a homeowner does a particularly good job of water conservation, Total N concentrations may double, making it virtually impossible to meet a < 10 mg/L standard. With inadequate alkalinity, meeting a < 10 mg/L standard is problematic and climate does have a big impact on treatment performance.

So, if a performance standard is not met, then what? Are homeowners going to be left holding the bag facing substantial additional spending?

Performance standards may also not be met due to installation problems, design flaws or problems with the technology when operating under certain conditions not

[11] Septic Systems Become Hot Topic, John Henderer, The Chronicle, 2/13/99.

tested, despite being certified through independent standardized testing protocols. If standards aren't met, who pays the bill? What enforcement action will be taken?

The insurance program pioneered by Bill Stuth offers a promising solution to insure that money is available should there be problems. Another solution, which doesn't protect current homeowners, is the one taken by several counties surrounding Des Moines, Iowa. As a result of persistent problems, these counties have banned the use of all "mechanical" systems. Is this fair to manufacturers and installers tainted by the problems of others?

6. Are we talking about O&M or just inspection?

There is a major difference between inspection and O&M. Inspections <u>may</u> tell us if a piece of equipment is operating correctly or if an obvious failure is occurring (sewage surfacing). Inspections, however, will not typically tell us how well the system is operating, what adjustments should be made to improve performance, what preventative steps should be taken to head off likely future problems, problem diagnosis, etc. Many inspectors only want the scope of their work to include a specific piece of equipment. "Why would we waste our time with the drainfield" is a comment all too common from Michigan to Georgia to Texas to Washington. Knowing whether just the mechanical components (e.g., pumps and blowers) are operating properly is only part of the equation.

True O&M involves a significant amount of troubleshooting and problem solving. We want to head off looming problems and achieve design treatment performance. We need system operators, not inspectors.

7. Is O&M affordable to the homeowner yet profitable enough to O&M providers to get quality O&M service? Do the economics work?

The going rate for residential O&M in Western Washington ranges from $75 to $100/visit including paperwork reporting to county health departments. With reasonable density (services/day) and no more than 1 hour per service call, the economics appear to work considering equipment required and going wage rates. There is also reasonable time for homeowner education.

However, if there are problems or some further action needs to be taken, these economics may not work. The amount of time it takes to communicate with homeowners about problems or further maintenance that is needed can be considerable. Getting paid for services rendered can be a major problem. The very structure of the contract easily leads to inspection and not to needed diagnostic or troubleshooting efforts. Homeowner turnover, which can be considerable, adds to the challenge and education efforts needed.

Many of the best O&M providers I know (e.g., Dan Bush with Septic Technologies in Oregon and Bill Stuth with Aqua Test here in Washington) do little residential work. What does this tell us about the economics of providing residential

O&M/inspection service even in a relatively high paying region like the Pacific Northwest?

Conclusion

The movement by our industry to embrace O&M is exciting and critical to our future. The challenges ahead, however, are enormous. A hiking analogy may serve to illustrate.

How many of you have found yourself hiking up a trail, sweating profusely, huffing and puffing, feet aching, slogging your way along to the top of what you are told is a spectacular view ridge? At last, you see the trail open up ahead and go around a corner, reaching what you pray is the summit at last. When you get there, you find the summit is a false summit. Not only is it not the top, but a new ridge looms high overhead and the trail gets even steeper. The hardest part lies yet ahead.

In many ways, that is where we now are as an onsite industry. Despite all our progress, the toughest climbing is yet ahead. Providing effective O&M is among the greatest of the challenges we face. Are we up to the task or is centralized management an inevitable and major part of our future?

UST Releases and Shallow Domestic Well Problems in Maryland

Forest Arnold and Kenneth Carter - Oil Control Program, Maryland Department of the Environment

Abstract

Under many state UST programs, cleanup goals for UST releases are determined using formal and informal risk assessments. Many older suburban areas often have a mix of water supply including city water supply, deep wells in regional aquifers and occasional shallow unconfined aquifer wells. Due to the nature of petroleum hydrocarbon releases, contamination is most often shallow and city water supply or regional aquifers are not usually at risk. Cleanup goals can be focused on removing free phase product and containing dissolved contamination on the site property. Cleanup of shallow groundwater to drinking water standards is not appropriate for protected water supplies and natural attenuation may be utilized to address remaining low level dissolved contamination with minimal risk to water supply.

The presence of an old shallow well in the vicinity of a site can dramatically change the risk scenario. Often these shallow wells are associated with older weekend cottages or rural properties which existed before the neighborhood grew up around it with a more modern water supply. In many cases county zoning will not permit such shallow wells to be used for water supply any more. In some cases county health departments are not aware of the presence of these wells or are unwilling to condemn these wells in low income neighborhoods because of the financial burden on the residents.

These wells are vulnerable to petroleum hydrocarbon contamination from the following: (1) surface runoff; (2) home heating oil line or tank releases; (3) leaks from gas cans, lawnmowers, power boats, or other personal motorized equipment; (4) leaks from car, boat or other repairs conducted at the residence, and (5) poor regional quality typical of unprotected shallow groundwater which can be impacted from other neighboring land uses. It is difficult to determine the source of contamination in these shallow wells, even if there are neighboring properties with UST releases. This makes it hard to define the appropriate cleanup goals or who is responsible for replacing the water supply. A series of case studies in coastal plain, piedmont and fractured rock environments will be presented to demonstrate the nature of the shallow well dilemma.

Biography

Forest Arnold is a Regional Geologist with the Oil Control Program of the Maryland Department of the Environment. He received his undergraduate degree from the University of Virginia and an M.S. Degree from the University of Maryland. He has twenty three years experience working on surface and groundwater contamination problems.

Forest Arnold, Oil Control Program, Maryland Department of the Environment, 2500 Broening Highway, Baltimore, Maryland, 21224, Phone- 410-631-3387, Fax – 410-631-3092, email – farnold@www.mde.state.md.us.

Biography

Kenneth Carter is a Regional Geologist with the Oil Control Program of the Maryland Department of the Environment. He received his Bachelor of Science degree from the Pennsylvania State University. He has 11 years experience working on UST and groundwater contamination problems.

Kenneth Carter, Oil Control Program, Maryland Department of the Environment, 2500 Broening Highway, Baltimore, Maryland, 21224, Phone- 410-631-3670, Fax – 410-631-3092, email – Kcarter@www.mde.state.md.us.

UV Disinfection of a 350 GPM Groundwater Supply

Carol Walczyk, Hatch Mott MacDonald

Abstract

The Southeast Morris County Municipal Utilities Authority serves approximately 50,000 customers. Supply is obtained from a combination of ground and surface water sources. The groundwater wells range in capacity from 250 to 3,500 GPM. Up until the late 1980s, gas chlorine was used for disinfection of all of the sources. With the advent of the Toxic Catastrophe Prevention Act regulations, gas chlorine was replaced with liquid sodium hypochlorite. While sodium hypochlorite has eliminated the operational risks associated with gaseous chlorine, the addition of liquid sodium hypochlorite has occasionally been problematic especially at well stations where the wells are off-line for several hours and the chlorine gas can come out of solution, air-binding the sodium hypochlorite feed pumps.

The Authority has been considering the use of UV disinfection as a method of providing additional protection against potential pathogen contamination, especially at wells which may be vulnerable to potential pathogen contamination.

One of the Authority's wells, referred to as the Sandspring Well, has a capacity of 350 GPM. Although not classified as Groundwater Under the Direct Influent of Surface Water, the well is in close proximity to a pond and nearby horse farm. The well is rock well, approximately 80 ft deep. The well water is of good quality meeting all regulatory requirements. The Authority has detected non-coliform bacteria in the well water, however, due to the addition of chlorine, has not detected any bacteria in the distribution system. In order to improve and provide a redundant level of disinfection at this source of supply, the Authority has added an ultraviolet light (UV) disinfection system to inactive any bacteria that may be found in the well. The UV system was added as part of an overall reconstruction of the well station facility.

This paper will discuss design and implementation of the UV system. Raw water quality characteristics including historical microbial inorganic contaminant levels and UV absorbance will be presented. This will be followed by a discussion of the UV equipment evaluation and design and startup issues. Issues of importance regarding the UV selection included: potential fouling as a result of the raw hardness and UV lamp temperature; the ability of the UV system to cycle based on operation of the well; power consumption; lamp replacement frequency; and capital, operating and lifecycle costs.

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A Geochemistry Discussion of Iron Sand Remedial Treatment of Arsenic and Chlorinated Hydrocarbon Compounds in Ground Water

Jim Lolcama, Principal Geochemist, KCF Groundwater, Inc., 11223 Troy Road, Rockville, MD 20852

Abstract

Zero-valent iron sand removal of arsenic and chlorinated hydrocarbon compounds is a proven remedial treatment method for contaminated ground water. The iron sand experiences rapid anaerobic corrosion in the presence of ground water yielding hydrogen gas, ferrous iron, and hydroxide ion, which dissolve into the water. The corrosion reaction rapidly decomposes the chlorinated hydrocarbon compounds by abiotic reductive dechlorination. Also occurring within the iron sand are complex reactions of mineral precipitation and co-precipitation which remove arsenic, sulfur, and iron from ground water. Modeling of the complex set of reactions is used for scoping assessment of a particular remedial design for ground water. A state-of-the-art reaction path simulator is employed for the corrosion and precipitation reactions. A mass balance approach uses the simulation outcome to predict the removal rate for chlorinated contaminants.

In one recent application, the modeling system was employed for an iron sand pilot scale treatment system to evaluate the life expectancy of the system, the rate of corrosion, the rate of removal of chlorinated compounds, the arsenic removal rate, and the volume and rate of formation of secondary minerals inside of the reactor. Ground water contaminated with arsenic, TCE, DCE, PCE, TCA, DCA, chloroethane, vinyl chloride, chloroform, and methylene chloride flowed into the iron sand.The calcium-bicarbonate ground water was reducing, with a pH of 6.0, and with moderate quantities of ferrous iron and sulfate. The pH of the treated ground water rises from 6 to about 9 from the anaerobic corrosion reaction. The life of the reactive sand was estimated at 50 years. Ferrous iron in the ground water is removed by formation of reduced iron minerals within the reactor, such as magnetite. A 3:1mole ratio of iron sand to TCE is required for reductive decomposition. Ratios were calculated for all chlorinated compounds in the ground water and summed together to give the cumulative ratio of iron sand to contaminant. The total weight of iron sand required to treat the ground water for one year was calculated at 6 kilograms. This compares with the 825 kilograms of iron sand consumed by anerobic corrosion in one year. The formation of large quantities of magnetite within the reactor over its life is beneficial to scavenge large quantities of arsenic. Arsenic will substitute into the magnetite mineral structure. Elevation of the pH of the bicarbonate ground water during anaerobic corrosion causes the formation of calcite, which may cause scaling of the reactive sand media. Pyrite can form in large quantities inside the reactor from ground water with large sulfate concentrations.

Use of Fluorometric Methods to Determine Sources of Bacterial Contamination in Drinking Water Systems near Boonsboro, Maryland

William Evans, Drinking Water Monitoring Section, Maryland Department of the Environment

Abstract

The Maryland Department of the Environment (MDE) has administered the wet/ dry weather bacteriological analysis of untreated (raw) water supplying public drinking water systems in Washington County, Maryland. Several drinking water systems located north of the town of Boonsboro have exhibited elevated levels of the sanitary indicator organism fecal coliform coincident with precipitation, indicating that groundwater aquifers are under direct surface water influence, referred to as 'GWUDI' (i.e., Ground Water Under Direct Influence). In response to these findings, the Drinking Water Monitoring Section of MDE launched an investigation using the latest technological advances in fluorometric procedures to “tag and capture” potential sources of contaminated water that may be infiltrating the wells in question. This investigation is designed to identify specific source(s) of contamination that may be causing wells to be GWUDI and to distinguish between hydrogeologic sources (ex, sinkholes) and on-site waste disposal (septic) systems. Multiple GWUDI systems were the subject of this investigation due to their close proximity, including Scenic View Mobile Home Park, Yellow House Restaurant, The Old Pike Inn, Boonsboro Produce/ M&T Bank, and Tri-state Academy. In addition, the Warrenfeltz and Keedysville springs, which serve the Town of Boonsboro, will be evaluated to further document regional groundwater dynamics and source water recharge areas. The primary goal of this investigation is to determine if remediation can occur in GWUDI systems without involving additional water treatment.

St. Mary's County Ground Water - Status, Problems, Solutions

John B. Wheeler, Chairman, St. Mary’s County Water Policy Task Force

Abstract

This presentation will introduce the symposium to the latest information on the quality and quantity of ground water in the County. The presentation will be made by the St. Mary's County Water Policy TaskForce which has been in continuous operation since November 2000. The power point briefing will, exclusive of questions, take approximately 20 minutes. It will contain the latest confined aquifer, water simulation results prepared for the County by the MGS and the conclusions and initiatives which have resulted there from. It will also contain a brief discussion of ground water arsenic within the County's aquifers.

Alaskan Earthquake Mysteriously Thieves Water from Pennsylvania Municipal Supply Well?

Mark W. Eisner, P.G. and James M. Wilburn, IV, Advanced Land and Water, Inc.

Abstract

In late 2000 and early 2001, a municipal supply well was drilled and tested at a subdivision being developed in Littlestown, Adams County, Pennsylvania. The underlying geology is the Conestoga Limestone of Ordovician Age. The well is completed to 300 feet, with 70 feet of casing and a single fracture at 127 feet; it had an original blown yield of over 100 gallons per minute (gpm). A step-drawdown and 72-hour pumping test were performed at a constant 90 gpm withdrawal rate. The water level remained well above the fracture, and recovery was both rapid and complete. All surrounding municipal and domestic wells were monitored during testing; none displayed test-correlative drawdown. A permit for 68 gpm was issued, and the well stood by while engineering and construction work to achieve its connection to the Littlestown system could be completed.

Nearly two years later, on November 20, 2002, personnel mobilized for a pre-operations test and found the static level in the well unchanged. Surprisingly, at 68 gpm, the water level in the well drew all the way down to the fracture in just 10 minutes. Subsequent retesting of the well confirmed this change in well performance. Its safe yield had fallen to an estimated 2 gpm; possibly less.

Drilling a replacement well was impossible, as wellhead protection constraints limited options as the subdivision was built out. Rehabilitation and reconstruction options were risky, uncertain and expensive. The unchanged static conditions and still-rapid recovery response ruled out well interference and drought effects. The detailed manner in which the initial test was performed eliminated test water recirculation as a possibility. A downhole camera survey was performed, and eliminated well bore integrity problems as a contributing factor. Two theories appeared the most likely reason(s) for the cutoff of flow to this well: (1) grouting of contributing fractures during the abandonment work of nearby wells, and/or (2) the remarkable and continent-wide effects of the early November 2002 Alaskan earthquake. Newspaper accounts (including a front page article in the Baltimore Sun late in 2002) detailed continent-wide hydrologic effects caused by the earthquake.

According to the USGS, the magnitude 7.9 quake that hit Central Alaska on November 3 (the “Denali” Earthquake) was the world's biggest earthquake in 2002, and the largest to hit the United States since 1996. The USGS also reported that Lake Pontchartrain in Louisiana sloshed about, and wells in several states including Pennsylvania produced muddy water. Water levels fluctuated in several USGS monitoring wells in Pennsylvania, and some have not returned to their previous levels. The USGS now believes that, in some cases in Pennsylvania, the earthquake subtly changed the connection between certain wells and the aquifer.

After due consideration of other rehabilitative techniques such as acid injection and conventional redevelopment, equipment was mobilized to hydro-fracture the well. Field observations suggested success in restoring (at least some) well-aquifer connection, and the earlier step-drawdown and 72-hour constant-rate tests then were repeated.

The retest data indicated that the well hydraulics had improved substantially because of hydro-fracturing. Some benefit clearly had been realized. The well no longer was capable of sustaining the permitted 68 gpm permitted pumping rate. The well probably cannot exceed 40 gpm on a sustained basis, but it may prove capable of providing at least 30 gpm. In conclusion, it appears that the 2002 Denali Earthquake may have robbed more than half of the sustainable yield from this southern Pennsylvania supply well.

An Optimized Observation-Well Network for Monitoring Ground-Water Levels in Maryland

Doug Yeskis, U.S. Geological Survey

Abstract

A consortium of Federal, State, and County agencies supports the statewide ground-water monitoring network in Maryland. The network consists of 180 observation wells that are measured and maintained by the Maryland Geological Survey (MGS) and the U.S. Geological Survey (USGS). The ground-water network has evolved since its inception in the mid-1940s, and it has a variety of goals and potential uses. The primary goals of the network are to obtain water-level records over representative geographic areas for all important aquifer systems, and to provide long-term information for assessing trends. Information from the network can be used for public education, planning, research, or early warning of potential supply or environmental problems.

An ad hoc workgroup was formed to evaluate the network at the request of the Maryland Water Monitoring Council. The workgroup consists of representatives from Baltimore, Carroll, Montgomery, and Prince George's Counties, the MGS, the Maryland Department of the Environment and the USGS. The workgroup has developed criteria for the ground-water-monitoring network to assess the effects of land-use changes, current and future water uses, and climatic variation on ground-water levels. The evaluation of the network is being completed by analyzing different components of the network (sub-networks), which include the confined aquifers east of the Fall Line, the shallow ground-water-flow system across the state, the overburden west of the Fall Line, several major pumping centers, and representative locations where surface-water/ground-water interactions occur. Different subcommittees assessed several sub-networks and the entire workgroup held bimonthly meetings to discuss issues and provide subcommittee updates. The workgroup will publish the evaluation of and recommendations for the ground-water network in a forthcoming USGS report.

Radium in Ground Water and Formation Geochemistry at Two Coreholes, Anne Arundel County

Mark Duigon, Maryland Geological Survey

Abstract

Two boreholes were drilled to sample aquifer materials in order to gain insight into the causes of high radium concentrations in ground water at some locations in the coastal-plain aquifers of Anne Arundel County, Maryland. The first borehole sampled the Magothy and upper Patapsco Formations (in which relatively high radium concentrations—up to 66 pCi/L of ^{226}Ra plus ^{228}Ra—have been found in ground-water samples from some locations). The second borehole sampled the Aquia Formation (in which high radium concentrations have not been found in ground-water samples, although high radon concentrations—median 328 pCi/L compared to median concentration of 180 pCi/L in ground water from the Magothy and Patapsco Formations—have been found).

Based on the results of this study, the following mechanisms are proposed to explain the difference in radium and radon concentrations of the Magothy and Patapsco Formations and the Aquia Formation:

- Detrital zircon from Piedmont source rocks is the main source of the radium progenitor nuclides thorium and uranium
- Uranium and thorium may also be incorporated in the mineral lattice of authigenic glauconite in the Aquia Formation
- Thorium that entered Magothy and Patapsco Formations ground water has been advectively transported owing to low pH of the aqueous environment
- Thorium that entered Aquia Formation ground water has precipitated onto formation sediment grains
- Radium produced in the Magothy and Patapsco Formations by dissolved thorium or ejected by alpha recoil tends to remain dissolved
- Radium produced in the Aquia Formation tends to be removed from solution by cation exchange
- Radium trapped in gain coatings or held at exchange sites in the Aquia Formation is a source for higher radon concentration compared with radon concentration in the Magothy and Patapsco Formations

Evidence in support of these mechanisms includes the presence of zirconium, uranium, thorium, and radium in the formation materials. The lack of correlation between thorium and zirconium concentrations in Aquia sediments, in contrast to the positive correlation in Magothy-Patapsco sediments, is evidence for the presence of thorium in grain coatings and in glauconite as well as being present in zircons. Higher values of effective cation exchange capacity were measured in samples of the Aquia Formation (median 12.15 milliequivalents per 100 grams) than in samples of the Magothy and Patapsco Formations (median 2.55 milliequivalents per 100 grams and 1.85 milliequivalents per 100 grams, respectively).

Application of Geophysical Methods for Groundwater Characterization

By Beth A. Williams, P.G.
ARM Group Inc.

Abstract

Geophysical methods have historically proven to be valuable remote sensing tools for the evaluation of groundwater systems. Recent improvements in older methods and the development of new methods in the geophysical industry have produced rapid advancements in the groundwater resources and wellhead protection realms of the environmental consulting world. Although there are numerous geophysical methods available today, a single individual method will not provide information for all of the geological and cultural scenarios encountered by groundwater scientists and water resource managers. The utilization of the most appropriate geophysical method allows the geophysicist to provide timely, accurate and concise information to the client. Available and appropriate methods include resistivity (electrical imaging), electromagnetics, seismic, ground penetrating radar, gravity, and borehole logging. By integrating one or several of these geophysical methods with the available geological information (i.e.; test pits, boring, wells, published material, fracture trace analysis), geophysics can be used to identify water supply targets, groundwater migration pathways, and groundwater impacted by contamination in the varying geologic conditions found in Maryland. Historically, funding and water supplies were abundantly available, but as budgets are reduced and aquifers get depleted, more advance investigations and planning must go into drilling new water supply wells. In the "Good Old Days", there was money to punch wells in the ground until enough clean water was found- those days are gone.

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ARM Group Inc. (ARM) is an earth resources engineering and consulting firm composed of 30 civil and geotechnical engineers, hydrogeologists, geophysicists, soil scientists, environmental scientists, natural resource managers, GIS specialists, and environmental planners. ARM serves an array of commercial, government and industrial clients in the Mid-Atlantic Region.

Pennsylvania Office
1129 West Governor Road
PO Box 797
Hershey, PA 17033-0797
(717) 533-8600

Maryland Office
5950 Symphony Woods Road
Suite 120
Columbia, MD 21044
(410) 740-0840

Tracking Ground-Water Levels from Historical Hydrologic Drought to Recovery
Wendy S. McPherson, Hydrologist, U. S. Geological Survey

Abstract

During the hydrologic drought of 2002, Federal, State, and local governments, water-resource planners, and the public used ground-water data to make decisions regarding water supply. Many monthly and all-time record low ground-water levels were recorded in wells used by the U.S. Geological Survey (USGS) to monitor climatic conditions in the Maryland. In June 2002, most of the ground-water levels were below normal. Six of sixteen wells reached their lowest levels in more than 40 years, exceeding the low water-level records set during the drought of the 1960s. Several months of abundant rainfall led to a full recovery from the drought and by June 2003, all the wells were at above normal levels, and six of the wells were at their highest level in 40 years. Record-low streamflow measurements in 2002 and record-high streamflow measurements in 2003 correlate with the record ground-water levels. The USGS Maryland long-term data show that this number of sites has never before shown such an extreme change in water levels during a short period of time.